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Model and Technique over Software Requirement Prioritization

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***Abstract*- Requirement prioritization play a significant part in overcoming problems related to requirements and it use to increase customer satisfaction. Requirement prioritization is use to verify the correct functionality of product and guarantee that the software is built within the given constrains, like budget, cost, value, time and etc. Requirements prioritization reliant on the specific requirements of customer along with prediction of importance and cost of each requirements. The approaches proposed in modern days to prioritize requirements have not been widely used because of its complexity, its inconsistency and its time-consuming factor. This paper represents an analysis on obtainable prioritization techniques based on cost and benefit and drawbacks evaluation of requirements. This paper represents a new approach of requirement prioritization, which can be easily managed, implemented and used as decision-making device by decision maker for requirement prioritization. It also overcomes the drawback of existing requirement approaches. The results of newly proposed approach shows that proposed model for requirement prioritization is simple and is useful for more refined critical decisions of prioritization, keeping in view the cost and benefit.**

Keywords: Software engineering, Requirement prioritization, Requirement Engineering, Elicitation, Method approaches, Negotiation approaches, Ordinal scale, Systematic research, Greedy algorithm, cost, risk, requirement.

I. Introduction

Software engineering has become an important discipline for creating the software that full fill the customer needs. In requirement engineering in the elicitation phase the analyst collect information from the stakeholders about their requirements, remove ambiguity and identify problem faced by them in requirements. They try to find best solution and make plans to develop software. Decision makers in software organizations during development phase are facing different problems, in selecting correct set of requirements for a specific release. To select correct set of requirements for implementation they must know the priority of every requirement. One of the characteristic of the requirement is that it can be explicitly prioritize. When expectations of customer are high, time given for development is less and resources are limited then it is difficult to carry out all requirements.

The requirement prioritization is useful for developer to take decisions about the implementation of requirements on the basis of many characteristics of requirements; such as requirement's benefit to user and business value, implementation cost, time etc. Industry analyst has developed several

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techniques for requirement prioritization that involve value and cost of individual requirement. Cost characteristic of the requirement help management of decision maker to use budget easily and in an efficient way. Mostly in requirement prioritization lower priority requirements are ignored so that their cost is helpful in achieving higher priority requirement to maximize business value. Sometimes requirement with greater priority is dependent on a requirement with lower priority, but to archive business benefits, decision makers are forced to implement lower priority requirements.

To gain customers satisfaction and business value the decision makers try to maximize the product value within given budget and time constrain. Until now none of existing companies know how to assign priorities to requirements. The main concept of requirements prioritization is the requirements prioritization process, which is consists of actions, that are performed on each requirement during their prioritization. The two main factors associated with each requirement are their benefit and cost. A procedure for prioritizing customers' requirements should be simple and fast, easy to manage and should give trustworthy results. By performing a survey on different requirement prioritization techniques a question was assumed that in which way requirements prioritization based on benefit and cost estimation currently is supported and by which available methods? Study answered it by using a systematic review of writing, drawing on our earlier work. The purpose of this study is to gain understanding of requirement prioritization techniques implanted in companies.

The prioritization method consists of three stages:

I. In preparation stage all the requirement from the customer are gained and arranged. Requirements are arranged in such a way that decision maker can apply required prioritization technique.

II. In execution stage prioritization of requirement is done using a specific requirement prioritization technique.

III. In presentation stage the optimized result of prioritization is presented.

II. Prioritization Techniques

In this section outline of different prioritization techniques and their drawback are described. The descriptions are defined one by one as followed.

A. Requirement prioritization techniques:

There are two category of prioritization.

I. Methods approach: methods are based on assigning quantitative values to different aspects of requirements.

II. Negotiation approach: it includes giving priorities to requirement according to agreement between stakeholders.

The requirements uncertainty prioritization approach (RUPA) [1] is basic prioritization technique in which Numerical Assignment is shaped as Extensive Numerical Assignment by possibility distribution and grade intervals. The main idea of transformation of Numerical Assignment was to have set of inputs, which are flexible enough to lodge vagueness. The backbone of the approach is interval evidential reasoning algorithm, which is used to combine the vague assessments of stakeholders. Framework consist of identifying the group of stakeholders, which should include developers to provide cost and risk ratings, customers who provide benefit, penalty ratings and Project Manager who judge conflicts and makes trade-off decisions. RUPA was implemented by Indian University named as Adikavi Nannaya. It is simple and fast prioritization technique but it does not give correct and trustworthy results and it is not flexible enough to lodge any ambiguity.

Numerical assignment is an approach that is use to distribute the requirements into different categories based on their importance like high, medium and low. It is important that each group help the stakeholders to do consistent classification of requirements. The group can vary but mostly groups are critical, standard and optimal. It prioritizes the requirements on an ordinal scale. 11 companies implemented different prioritization techniques. Out of 11 companies' majority used numerical assignment to prioritize their customer requirements. The sets of categories used by companies was critical, medium, and not critical. The main drawback of numerical assignment is that the usefulness of the requirement priorities is finished because the stakeholders are forced to divide the requirement into three groups.

The Detection and prevention (DDP) [6] method help developers to select the development activities (such as procedures, tests, and analyses) cost effectively and it prevent the hardware defects and detect. According to framework of DDP, assign each requirement a weight, which help developers use these to determine the importance of requirement. Then risks relate to requirements are assigned to indicate each delay is caused in customer requirement. Each mitigation is assigned an effort a cost. The cost is generally the financial cost, but other factors such as resources, schedule and utilization of memory can be considered. DDP cannot deal with continuous requirements and cost is indirectly achieved.

Value-oriented prioritization (VOP) is prioritization an approach in which requirement influences the business values of an organization [7]. The framework of VOP helps the developers to recognize the core values of the business and the associations between those business values. An executive of a company classify the business values. It uses a simple scale to weight the values of requirements according to the importance of an organization. Its framework identifies the weight of business risk. VOP formulate a prioritization matrix using core values and business risks. VOP

was tested by TBI (Technology Builders Incorporated) they decided to bound the value to a suitable size. TBI got many benefits by using VOP then the company's leaders firmly believe that VOP contributed directly to TBI's success.

The 100-dollar test prioritization and ranking techniques [8] are almost same. In 100-dollar test prioritization the stakeholders are given 100 imaginary units (money, cost, benefit, hours, etc.) to distribute among the requirements. In ranking the requirements are placed in a rank. The most important requirement is placed on top of the rank at first position and the least important is placed at the bottom at rank n in the list. For n requirements the requirements will be prioritized into n ranks. The list of ranked requirements could be obtained in a variety of ways like using sorting algorithms example by using the bubble sort or binary search tree algorithms.

Cost–value approach [5] is an analytic technique. Which help the developers to level candidate requirements by using two dimensions: according to their value or importance to customer and users, and according to the estimated cost of implementation of the requirements. The cost–value method is an entrenched analytical technique, with reasonable effort, provides a clear indication of the costs and values of all candidate requirements. To examine candidate requirements, Analytic Hierarchy Process (AHP) was used in which comparison of requirements is done pair-wise according to their value and cost. Ericsson's Radio Access Network project (RAN) implemented cost value approach. They identified 14 requirements then applied AHP on them. The software managers were able to efficiently and accurately prioritize their requirements. In cost value approach there are several issues of interdependencies of requirements and by applying AHP there is lot of complexity.

Quality function development (QFD) is used as methodology to describe relationship between the customer requirements and technical attributes like cost, importance, value. A relationship matrix is made to show impact of technical attribute of requirement and correlate show the dependencies of the technical attributes of the requirements.

Goal skill preference is used to generate a software design. In an analysis phase of goal preference, the requirements are given as input and it generate a set of ranked alternative that fulfill the customer's need. In design phase of software, the set of alternatives is used as software component for its architecture. To remove the drawbacks of above mentioned prioritization technique a new technique is developed, which is simple and east to implement.

III. Parameterised Requirements Prioritisation

After conducting literature review this paper extracted three major parameters from nine papers. The names of parameters are requirement, cost and risk. These are the major finding and have scales all of parameter with:

- *1= good finding.*
- *2= Average finding.*
- *3=low findings.*

TABLE I
SUMMARY OF REQUIREMENT PRIORITIZATION MODELS

S No	Models	Cost	Risk	Requirement	Remarks on high scale
1	A model for making early requirement	1	3	2	Cost is efficient due to resources
2	Requirement handles IKIWIS cot and Rapid change	3	1	1	Risk=time Requirement=va able
3	Value oriented model	1	3	3	Requirement=va e
4	Prioritization based on cost and benefit co prediction	1 s	1	1	Cost=software economics Requirement=co
5	A cost value model.	1	3	3	Requirement=su et.
6	Prioritization o quality requirement	3	3	3	
7	Requirement prioritization	3	3	3	
8	Requirement	1	3	1	Requirement=pe
	uncertainty approach				alty Cost=optimal solution
9	Requirement in priority in agile	1	3	1	Cost=size Requirement =acquisition

After studied of different papers this study concluded that each author is trying to propose much complex/complicated or ambiguous model. Authors of this paper have suggested or proposed a very simple model for requirement prioritization and use more refined ones, especially when a more sensitive analysis is needed for critical decisions.

IV. MODEL OF PARAMETERISED REQUIREMENTS

In the proposed model the square shows entity and oval sign represent process. The whole scenario proposed software prioritization consist of two entities and five process and main process consist of requirement, cost and risk. Requirements are going to ask from client by the project manager; then the project manager will compile the requirements and get compile data; later that compile data is converted into optimal data. Optimal data will help to decide cost and on basis of cost will enable us to determine if project is on risk or in profit.

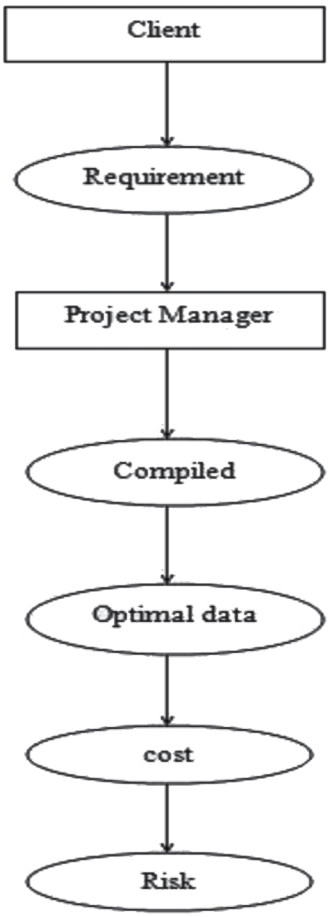

Figure 1: New proposed model for prioritization

A. Greedy algorithm (High level algorithm)

In general, greedy algorithms have five components:

1) A requirement set, from which a solution is created

2) A selection function, which chooses the best requirement to be added to the solution

3) A feasibility function, that is used to determine if an estimated requirement can be used to contribute to a solution

4) An objective function, which assigns a value to a solution, or a partial solution, and

5) A solution function, which will indicate when to discovered a complete solution

B. B. Low level algorithm

Low level algorithm, steps of the algorithm are given below:

1. *Find requirement from user side...*
2. *Requirement [ ]=a [n]*
3. *Estimated [] =Requirement []*
4. *While (True)*
5. *If (Estimated [n] == weight[n]);*
6. *Cost=Estimate*
7. *Print "Cost"*
8. *Else If (Estimated[n]>=weight[n])*
9. *Risk=Estimated*
10. *Print "Cost"*
11. *Else if (Estimated[n]<=weighted[n])*
12. *Cost=Estimated*
13. *Optimal solution*
14. *End*

In above algorithm first the project manager will ask the requirements from the customer are stored in an array. a [ ] is such alpha numeric array which will get the maximum requirements from user and this array in another array of Requirement so that algorithm will become user readable. Requirement [] containing possible array which tried to extract functional requirement from the possible requirement array so that it can lead this algorithm to successful system. Then in next step try to give ranks to requirements and then *1.* These ranks give weight to requirements. To give weight and have to initialize another array of weight. If the rank of requirement is high than it can find the cost of the requirement; that will be effective value, which leads towards a very successful system. If in this case weight of all requirements are highly ranked than best or optimal requirement cost will be able to find. But if weight requirements are less than estimated than system will be on Risk. The variable n which help to determine number of customer requirements.

V. Implementation of the Model

Flow chat describing the flow to requirement prioritization of proposed model, as shown in Figure 2.

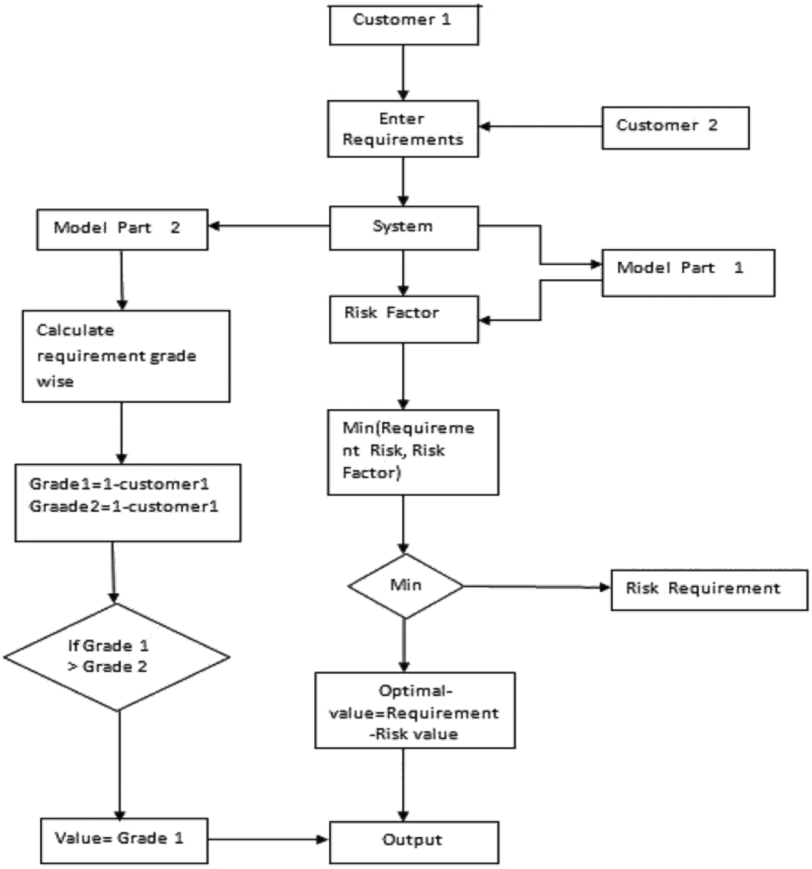

Figure 2: Flow chat of proposed model for prioritization

An experiment was performed by coding this model in Microsoft visual studio 2013 using C++ language. Few functions are given below:

Function for model part 1:

The function of model part 1 is given below:

```
int model part 1( )
{
float wt_act,wt_database, wt_stock, wt_model, wt_customer, total_wt, minimum, risk,req_
risk,value; if (choice2==1)
{
total_wt=wt_act+wt_database+wt_stock+wt_model+wt_
    customer; total_wt=total_wt/100; cout<<total_wt<<endl; float value1, value2,
```

```
                value3, min,risk_fact=0.1, mitg; value=100.0*(1.0-min(1.0,risk*req_risk));
                value1=risk*req_risk; value2=min(1.0, value1);
    if(value1<1.0)
        {
        min=value1; value2=min;
        }
    value3=1.0-value2; value=(100.0*value3)/100.0; minimum=min(wt_act,wt_database);
for(float i=r;i>=0;i--)
        {
        value=value-risk_fact; cout<<"mitigated value"<<value<<endl;
        }
        }
```

This novel model mainly consists of two entities named as customer and developers. These two entities have three main parameters, which are requirement, risk and cost. These parameters will be input in the model which will give some discrete values and these discrete values are point based like 0.1 to show probability. The main and important parameter is requirement. Customer will enter requirement and will see simulated values from various formulas. In this paper model is divided into two parts. In part I single Customer, the one who can enter the requirement. These requirements will pass into system. System will check the requirements, which will hold two things, risk factor and other is requirement factor. Our defined function will take minimum factor from these two parameters. In this system given weight age about 0.1 to general risk value from requirement and minimum requirement value will be subtracted from risk value for the optimal value.

Function for model part 2:

The function of model part 1 is given below :

```
float model part 2( )
{
    model1 l2,l3; float j,t,t1;
    int i;
    cout<<endl<<"enter first requirement"<<endl;
    t=l2.l1.req1; cin>>t;
    t=1-t;
    cout<<endl<<"enter second requirement"<<endl;
    cin>>l3.l2.req1; t1=l3.l2.req1; cin>>t1; t1=1-t1; cout<<t1; cout<<endl; float l4,k,g;
l4=t*t1;
```

```
cout<<endl<<"total of two stake holders probability"<<l4<<endl;
//k=1-l4; //cout<<k; if(t>=t1)
{
g=t;
cout<<"this is high priority requirement from two stake holder"<<g;
}
//l1.req[i]+l2.req[j];
//for(int i=0;i<=4;i++)
{ l2.req[i]=5*l1.req[i]; cout<<l2.req[i];
}
}
```

In second part of model, study proposed two stakeholders means two customers and they are giving requirements individually. In this model both customer 1 and customer 2 will enter the requirements in second part. After having requirements, will try to find grade value. Total probability is 1 value for customers 1 and customer 2. After subtracting requirement from total will find grade values. If grade value will be higher, then probability of getting requirement is important.

VI. Experimental Results

Here above mentioned model in figure 2 is followed, in which the diagram of proposed system is drawn, is dividing into two path, one is model part 1 and other is model part 2, in model part one mathematical formulation is drawn and can be shown in graphe1 below; in graph x axis is consisting of input and output parameters and y axis is giving values of input parameter, higher value from graph. It is noted that that higher values are mitigated higher risk values after taking five requirements value in this simulation, which can be extend up to n .

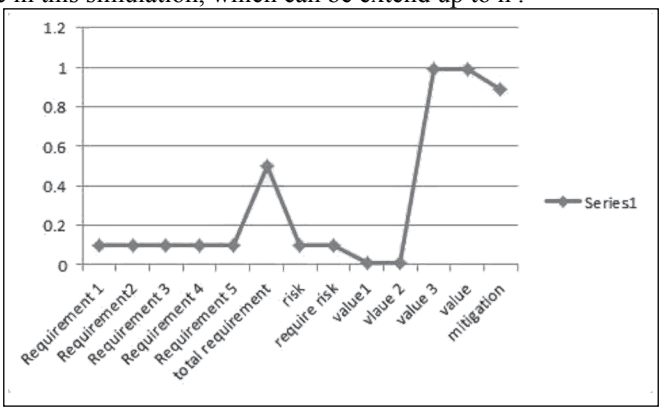

Figure 3: Graph for proposed model part 1

In model part 2 if consider the case, where two customers or they may be more than two from figure number 2; it can be clearly shown the simulation and also shown in the graph, which have been found from code below; where x axis is consisting of two customers and they are after giving their probability value and finding grades requirement value and customer grade parameter can be found on x axis and on y axis can see their values. Higher value shows that customer has high value of risk whereas low value shows less risk, from graph risk become 0.7 from 0.8 because using directly minimal value to minimize the risk.

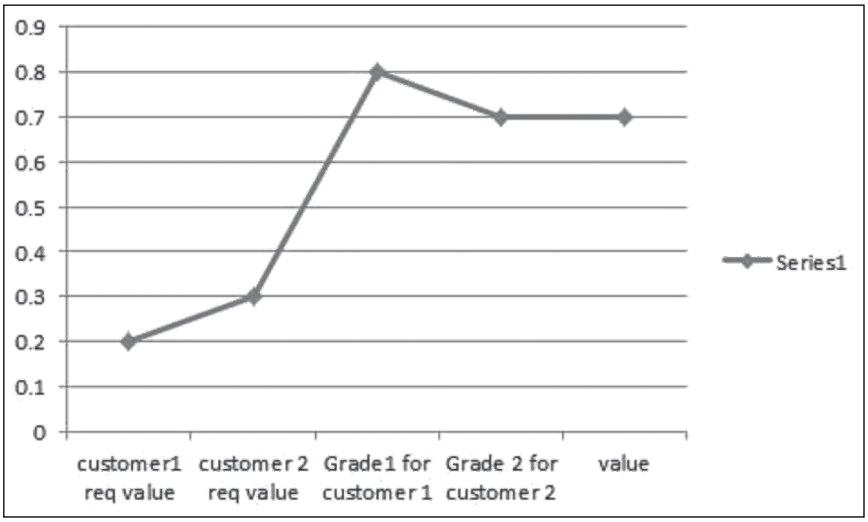

Figure 3: Graph for proposed model part 2

VII. Conclusion and Future Direction

Requirement prioritization is introduced to find most important requirement that add greatest value to business. It helps out the developer to take important decisions related to requirement implementation. The low priority requirements are dropped so that time, cost and resources are saved and Prioritization technique to be implemented must be fast, easy to manage and should give trust worthy results. The model proposed in this paper is simple and use more developed ones, when a more sensitive analysis is done for requirements. In proposed model the requirements are given by client to the project manager and the project manager will compile the requirements into compiled data and that compiled data will be converted to optimal data. Optimal data will help to determine cost and on basis of cost it will be enabled that either the project is on risk or in profit. The results show that proposed model for requirement prioritization is simple, fast and it use provide refined decisions for prioritization according to cost and benefits.

An increase in customer requirements causes an increase in requirements prioritization techniques. When there are many requirements then the prioritization could be done in early stages and need to manage with change in customer needs. Many new prioritization techniques are introduced in industry, but their scalability is not tested. Future efforts could be made to refine this model. More investigation could be done on the relationship between resources of requirement and the technical attributes. A survey on requirement prioritization techniques is performed.

This work is a model in such a way that system is involving three parameters requirement, risk, cost. Customer is main entity who is giving specification to developer and developer tries to accurate requirements so that a risk free system can delivered, but in future this may transplant into an intelligent system, which will consist of various models and this system will play the role of developer and customer will give requirement to intelligent system and intelligent system will apply intelligent calculation on user given requirements and find an optimal risk free customize solution on hands on.

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